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Inventory of radioactive waste and spent fuel

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Inventory of radioactive waste and spent fuel

Edition 2004

ENRESA

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Resumen

Resumen

ENRESA, desde su creación, ha elaborado y mantenido un inventario de los residuos radiactivos existentes en nuestro país, a partir de los datos recibidos de los productores. En un primer momento, con el fin de preparar el primer borrador al 1er Plan General de Residuos Radiactivos, se estudió, con los medios disponibles, la situación a 1 de enero de 1986 de los principales centros generadores de residuos radiactivos.

Posteriormente, con la colaboración de las empresas eléctricas, los centros hospitalarios y de investigación, las empresas industriales que utilizan isótopos radiactivos, etc., se ha ido mejorando el conocimiento detallado de la situación, lo que ha permitido elaborar con mayor precisión las estrategias y los programas de gestión correspondientes.

Con el fin de facilitar la disponibilidad de datos, se han desarrollado sistemas informáticos que permiten obtener información de forma instantánea sobre la situación y sobre las proyecciones a corto y medio plazo, las cuales facilitan a su vez las extrapolaciones a largo plazo.

Este documento constituye una síntesis del inventario de residuos radiactivos, en base a la información existente en ENRESA. El inventario está dirigido, fundamentalmente, a proporcionar una información sobre el volumen de los residuos que, a fecha de 31 de diciembre de 2004, se hallaban almacenados en cada instalación, así como a disponer de una previsión de generación en el futuro para todas las instalaciones productoras y, en consecuencia, a ofrecer datos sobre el inventario total de residuos a gestionar en España. Sin embargo, conviene señalar que los valores sobre las previsiones futuras dados en este informe están basadas en la experiencia de ENRESA y en estudios realizados, y se ha optado por redondearlos. Por tanto, estos valores pueden no coincidir con otros datos aportados en el pasado o con los que se den en un futuro.

Tras mencionar la clasificación de los residuos radiactivos que se utiliza en base a la gestión a dar, en el capítulo 3 de este documento se enumeran y describen someramente los centros generadores de residuos radiactivos y las características principales de los residuos que generan. Posteriormente, en el capítulo 4, se ofrece el inventario de residuos radiactivos, atendiendo al tipo de centro productor, incluyendo tanto el inventario del Centro de Almacenamiento de El Cabril, el cual, consecuentemente con la función encomendada a dicho Centro, está dirigido a ofrecer información relativa a las existencias actuales de residuos y a las previsiones de recepción de residuos en el futuro, como el de residuos existentes en instalaciones extranjeras que retornarán oportunamente a España, los cuales proceden del tratamiento de residuos generados en España y que fueron enviados en su día a dichas instalaciones.

Por último en el capítulo 5 del documento se efectúa un resumen de los datos expuestos en los apartados anteriores, ofreciéndose un inventario dirigido a cada uno de los tipos de residuos que tienen, cada uno de ellos, una vía diferenciada de gestión. En este capítulo se indican tanto las existencias al 31 de diciembre de 2004, como el inventario que, para cada tipo de residuo, habrá que gestionar en España.

Cabe indicar que, para este inventario al 31 de diciembre de 2004, se ha optado por no considerar dentro del mismo a todos aquellos materiales contaminados, almacenados provisionalmente en las centrales nucleares, sobre los cuales aún no se ha adoptado una gestión para su consideración como residuo radiactivo. Asimismo, los residuos líquidos contaminados o suspensiones de resinas de intercambio iónico que se encuentran almacenados en depósitos en las centrales nucleares, a la espera de su acondicionamiento como bulto de RBMA, no se han tenido en cuenta en este inventario. Finalmente, cabe reseñar que tampoco se incluyen los elementos combustibles que se están irradiando en los reactores de las centrales nucleares.

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1. Introduction

1. Introduction

Since it was founded, ENRESA has drafted and updated an inventory of radioactive waste in Spain, based on the data received from the producers of this waste. Initially, a study was made of the situation at 1 January 1986 regarding the main producers generating radioactive waste, using the resources available with a view to preparing the first draft of the 1st General Radioactive Waste Plan.

Subsequently, with the collaboration of the electricity companies, hospital and research centres, industrial companies using radioactive isotopes, etc. our detailed knowledge of the situation has improved. This has enabled us to elaborate strategies and management programmes with greater precision.

In order to facilitate the availability of data, computer based systems have been developed which allow information on the situation to be collected instantaneously for use in short and medium term projects, which in turn facilitate long term predictions.

This document constitutes a synthesis of the radioactive waste inventory based on the information available to ENRESA. The inventory is basically intended to provide information on the volume of the waste which was stored at each installation as of 31 December 2004, as well as providing a forecast of future waste generation for all producer installations and, consequently, supplying data on the total inventory of waste to be managed in Spain. Nevertheless, it should be pointed out that the values for forecasts given in this report are based on the experience of ENRESA and on studies carried out, and it was decided to round off the values. Therefore, this data may not match other data given in the past or at a possible future data.

After describing the classification of radioactive waste to be managed, chapter 3 of this document lists and briefly describes the radioactive waste producers and the main characteristics of the waste generated. Chapter 4 contains the inventory of radioactive waste, focused on the type of producer, including the inventory of the Disposal Facility at El Cabril, which, due to the mission entrusted to it, is responsible for providing information on the current stock of waste and the forecasts of waste to be received in the future, and the waste currently stored in foreign installations which, in time, will be returned to Spain as it had been waste treated in Spain and then Exported to these installations abroad.

Chapter 5 of this document summarises the data given in the previous chapters, providing an inventory of each of the types of waste which require a differentiated management process. This chapter also refers to the situation on 31 December 2004, as well as the inventory for each type of waste which will have to be managed in Spain in the future.

Finally, it should be mentioned that in the 2004 inventory, it was decided not to include contaminated material stored temporarily in the nuclear power plants where a management process had not yet been decided on with regard to classification as radioactive waste. Moreover, contaminated liquid waste or suspension of ion exchange resins which are stored in nuclear power plants, awaiting conditioning as LILW package pieces, were not included in this study. And lastly it should be stressed that fuel elements which are irradiating in the reactors of the nuclear power plants have also been excluded from this study.

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2. Classification of radioactive waste

2. Classification of radioactive waste

In Spain, radioactive waste is defined as any waste material or product for which no future utilisation is planned, which contains or is contaminated by radionuclides in concentrations or levels of activity superior to those established by the Ministry for Industry, Tourism and Commerce in accordance with the Council on Nuclear Safety Report.

Although there are many types of radioactive waste depending on their characteristics and management processes, with regard to their integral management they are divided into two main groups:

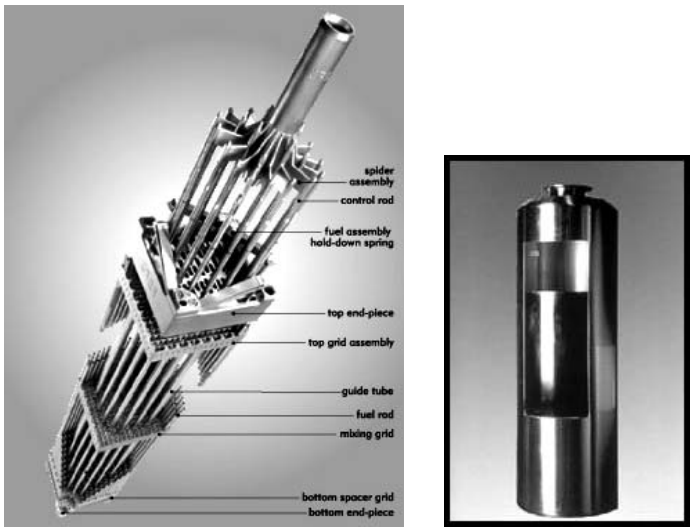
- Waste with low and medium level activity and short life (LILW): waste which is characterised by activity due primarily to the presence of beta-gamma emitting radionuclides with short or medium term semi-disintegration (less than 30 years) and which contain very low, long lived radionuclides.

  This group includes waste intended to be disposed of at the El Cabril nuclear facility and the so-called very low level radioactive waste (VLLW).

- High level activity waste (HLW): this contains long lived alpha emitting radionuclides in appreciable concentrations above 0.37 GBq/t, with a half lived of more than 30 years.

  This group basically includes spent nuclear fuel and vitrified products resulting from reprocessing, and other waste which is not suitable for being disposed of at the El Cabril facility due to its characteristics, and is called medium high level waste (MHLW).

Furthermore, in Spain, throughout recent decades, significant quantities of tailings from uranium mining and the production of uranium concentrates have accumulated and have naturally occurring low level radioactivity although this required special management due to the large amounts involved. Therefore, in this document, they are dealt with apart from the other radioactive waste.



View of a fuel element and vitrified waste.

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3. Radioactive waste producers

3. Radioactive waste producers

The main producers of radioactive waste are the nuclear power plants. However, there is also the waste generated in nuclear and radioactive installations within the nuclear fuel cycle, such as the Nuclear Fuel Manufacturing Plant at Juzbado, the uranium mining facilities, the uranium concentrate production installations, and apart from the cycle: research centres, universities, hospitals, industry, etc. Figure 1 shows the locations of all these waste producers in Spain.

The following sections describe the main characteristics of the producers and the types of radioactive waste they generate during operation.

3.1. Nuclear Power Plants

An overview of nuclear power plants in Spain is shown in Table 1.

All nuclear power plants in Spain have been operative as of 31 December 2004, with the exception of Vandellós I, which stopped operating in July 1990 and is currently in the latency period following dismantling to level 2 and awaiting complete dismantling to level 3.

For the purposes of creating an inventory of waste generation relative to the nuclear power plants, the following reference scenario was adopted:

- 40 year nuclear power plant service lifetime, except for the José Cabrera nuclear power plant which will be shutdown in April 2006. During the useful life of each plant, it is assumed that the operating process will continue to be similar to the present one.
- Open fuel cycle; that is to say, the option as regards reprocessing spent fuel is not taken into account.
- Total dismantling (Level 3) of the nuclear power plants. This process commences in light water reactors three years before the final shutdown.
- All low level and medium level waste generated at the nuclear power plants is conditioned at source and transported to the El Cabril disposal facility in a suitable condition to be disposed of.

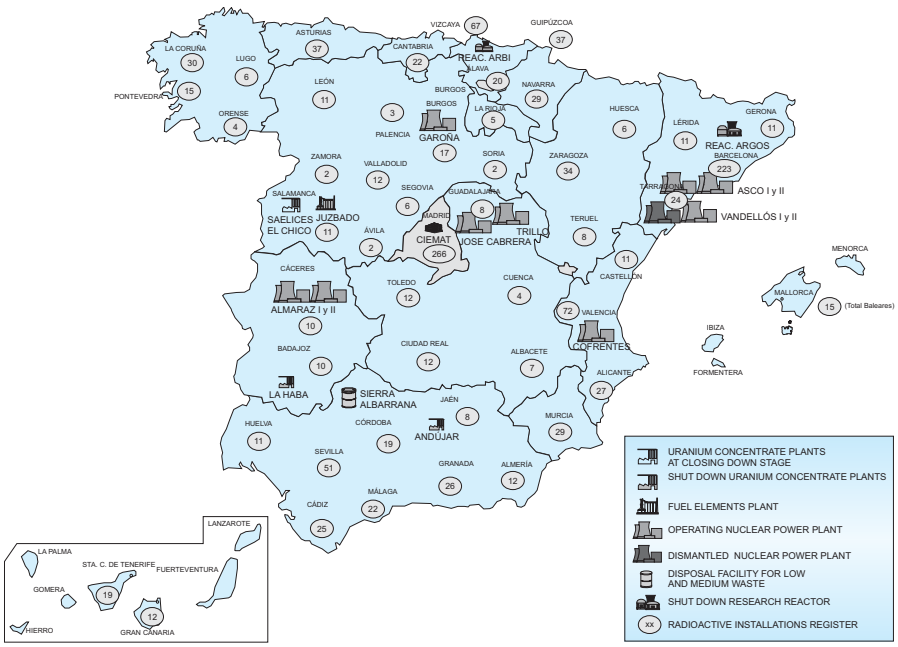


Figure 1: Producers of radioactive waste in Spain.

Table 1.
Overview of nuclear power plants in Spain

Nuclear power plant	Location (Province)	Type of Reactor	Electrical output (Mwe)	Start-up date of commercial operations
José Cabrera	Guadalajara	PWR	150	February 1969
Garoña	Burgos	BWR	466	May 1971
Vandellós I	Tarragona	Gas - graphite moderated	496	May 1972
Almaraz I y II	Cáceres	PWR	Unit I: 977	Unit I: July 1981
			Unit II: 980	Unit II: July 1984
Ascó I y II	Tarragona	PWR	Unit I: 1,032	Unit I: December 1984
			Unit II: 1.027	Unit II: March 1986
Cofrentes	Valencia	BWR	1,095	March 1985
Vandellós II	Tarragona	PWR	1,087	March 1988
Trillo	Guadalajara	PWR	1,066	August 1988

The source of waste originates from the fuel elements used in the reactor. A fluid circulates through the reactor in order to cool it and it is transformed into an energy transmitting medium generated by the fission of the U-235 in the fuel elements. This fluid is called the refrigerating fluid and consists of water with a very high level of purity in light water reactors. As it passes through the reactor, it is contaminated with the following types of radioactive isotopes:

- *Fission products* from the fuel elements which leak from the sheaths in very small quantities.
- *Neutron activation products* from components and impurities from the fuel elements, vessel, refrigeration circuit, etc.

During the passage of the refrigerating fluid through a series of units and systems of the plant, its fission content and activation products are transmitted. Afterwards, during the operations, the maintenance or dismantling of these units and systems, so-called radioactive waste is generated. This waste, which constitutes the bulk of radioactive waste, is composed of solid and liquid LILW.

The "solid waste" (cloth, debris, metal components, components of the staff protective gear, paper, wood, etc.) are placed inside normalised transport containers and the material which is considered compactable is compacted. Thus, two types of waste are generated and inventoried, compactable solid waste and non compactable solid waste.

"Liquid waste" (drainage liquids from equipment, cleaning floors, washing of clothes and showering, decontamination of equipment and components, etc.) is processed within the treatment systems of each plant by passing it through demineralising agents, filters and evaporators, which produce a clean fluid suitable for recycling or discharge, and a solution with concentrated radioactivity which, depending on the processing equipment, is classified as:

- Spent ion exchange resins
- Evaporator concentrates

- Sludge
- Filters (spent filter cartridges)

This concentrated waste is conditioned inside 220 litre drums, and forms a solid matrix by mixing with a hydraulic conglomerate (cement and additives), or it is immobilised by using a hydraulic conglomerate (mortar or concrete). Thus, four other waste streams are generated and must be inventoried: waste package from resins, concentrates, sludge and filters.

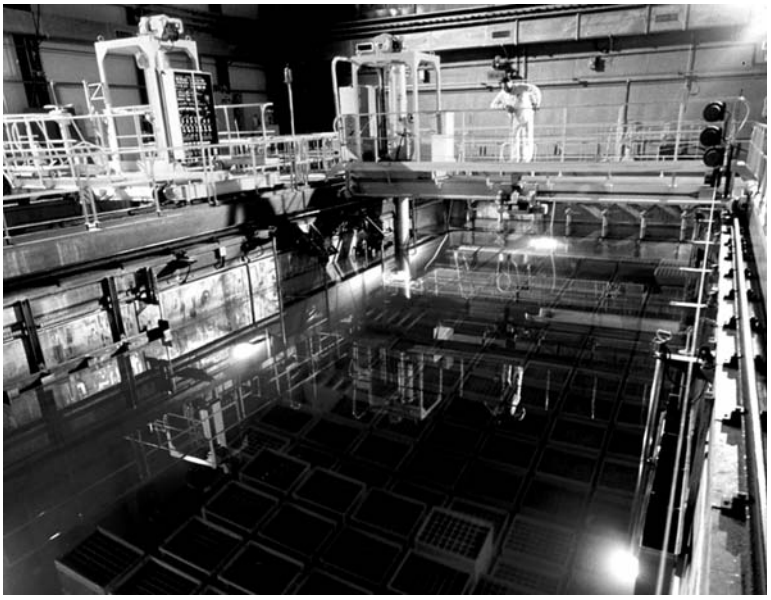
Over the last few years and as a result of the efforts to reduce the volume of LILW generated, desiccation systems have been installed in the nuclear power plants for concentrates and sludge waste streams. This concentrates the radioactivity of the waste in a solid product which is later conditioned for immobilisation using a hydraulic conglomerate.

In addition, once the useful time of fuel elements inside the reactor is over, these are taken to the pool for spent fuel; each nuclear power plant has such a pool. This constitutes a second source of waste generation although, in this case, it is more limited and is smaller in size

The spent fuel elements retain practically all the generated fission and transuranium products in their sheaths. Whether these fuel elements are considered as waste or not depends on the option selected when managing fuel. If it is decided not to re-utilise either U-235 which did not fission, or Pu-239 (open cycle), then the fuel elements must be managed as high level waste.

Currently, the nuclear power plants in Spain store the spent fuel elements in the pools of each plant and in the case of the Trillo nuclear power plant, in dry storage containers, placed in Individualised Temporary Storage (ITS). Afterwards, as an intermediate step prior to its final management, either in a deep repository or via a future management method they will be transported to a Centralised Temporary Storage (CTS).

However, if the decision is taken to exploit U-235 and Pu-239 (closed cycle), the fuel is sent to reprocessing installations where the energy material is separated to produce new fuel elements and a series of basically high level waste is generated. The closed cycle process was selected only for the nuclear power plant at Vandellós I, whose reactor is a



Fuel elements in the pool of a nuclear power plant.

Containers with spent fuel in the ITS at Trillo.

graphite moderated gas type, with the spent fuel elements being sent to France for reprocessing. The high and low and intermediate level waste generated during reprocessing will be returned to Spain as from 2010. Prior to 1983, fuel from the José Cabrera and Garoña nuclear power plants was sent to installations in the United Kingdom for reprocessing.

Furthermore, there is a group of waste associated with the spent fuel elements, called "special waste". This waste is composed of individual components which are inserted into the fuel elements or components of these produced during repair work and which have been exposed to neutron irradiation within the nuclear reactor. This group comprises control rods, burnable poisons, ducts, etc., which are stored temporarily in the fuel pools at each plant. Final management of this waste will be closely associated to the management of spent fuel.

At the end of the service lifetime of the nuclear power plant, the fuel is first removed from the reactor and then, after a cooling period, from the pool. At this time, all equipment and components of the plant which are radioactive, or are radioactively contaminated must be managed as radioactive material. At this stage, known as plant dismantlement, radioactive waste is again generated and conditioned. The bulk can then be classified as LILW, the greater part of which is compactable and non compactable.

3.2. Nuclear fuel manufacturing plant at Juzbado

The nuclear fuel manufacturing plant at Juzbado is located in the Salamanca region and began operations in 1985 and its activities involved the production of fuel elements of uranium oxide for PWR, BWR and VVER reactors. It has a production capacity of 500 metric tons of uranium per annum. Maximum enrichment is 5% of weight.

The radioactive waste produced in the Juzbado plant is solely LILW, which is generated exclusively from contamination of materials with uranium oxide and consists basically of decommissioned equipment taken out of service, materials used for clean-

ing as well as filters used in the extraction and cooling systems.

The contaminated materials classified as radioactive waste are divided into two groups:

- Radioactive waste composed of materials which have been in contact with dust or pellets, such as plastic and paper bags, material from the treatment of pre-filters and filters in the extraction system, cleaning material and others (grinding belts, molybdenum pellets and zircaloy tubes and plugs, etc.).
- Radioactive waste which is generated during maintenance work, repair and/or substitution of equipment and waste from new installations which have been in contact with uranium oxide such as: cables, electric panels, motors, electric and electronic components, aluminium, steel, metacrylate, glass, ceramic, oils, cleaning materials, tools, cloths, paper, plastic, etc.

On the basis of the characteristics of this waste, LILW packages generated in the facility belong exclusively to the group with specifications of compactable and non compactable solid types.

3.3. Research Centre for Energy, Environment and Technology (CIEMAT)

The Research Centre for Energy, Environment and Technology (CIEMAT) is located in Madrid and encompasses a complex of nuclear and radioactive installations. The nuclear installations are classified as non-operative as they are awaiting decommission. The project called the Integrated Plan to Improve the Installations at CIEMAT (PIMIC), consists of two parts, one which covers the dismantling operation which affects four zones or areas with nuclear installations and is expected to begin in 2006, and the other directed at rehabilitation which will cover the remaining 24 zones which the site is divided into. At the end of 2004, the rehabilitation process was declared to be complete in 14 of these zones.

The radioactive waste generated in the Centre itself has its primary source in the day to day operations of the research laboratories and a second source in dismantling operations involving the elements from installations which are not currently operative. The waste generated throughout the operations at the

View of the fuel factory at Juzbado.

Aerial view of the CIEMAT installations at Madrid.

Centre, and which forms the bulk of waste generated, consists of compactable and non compactable solids as well as aqueous and organic liquids.

In addition, a series of waste is generated which derives from the handling of waste previously carried out by Enresa and includes waste such as that from radium, neutron and alpha sources, headers and arrestor sources as well as the active parts of ion smoke detectors. Normally both this waste and the previous category are transported to Enresa without conditioning and the operation is carried out at the El Cabril facility.

3.4. Radioactive installations

Radioactive installations (RI) which use radioactive isotopes and are therefore subject to control by the regulatory authority, are generally grouped into one of the following three groups according to the type of activity they carry out:

- Medical installations
- Installations connected to industry and agriculture
- Research and teaching institutions

In 2004, a total of 1,330 RIs were authorised to operate, the majority located in the Autonomous Communities Madrid and Catalonia (261 and 260 respectively) followed by Andalusia (177), the Basque Country (119) and Valencia (112).

Although not technically RIs, non-regulated installations in the steel and metal recovery sectors are also classified as belonging to this group for inventory purposes when these installations detect metal scrap containing radioactive material within the scrap to be processed.

The characteristics of the installations in each of these three groups can be summarised as follows with regard to the generation of radioactive waste:

- Medical installations: characterised by the production of noticeable quantities of radioactive waste on a regular basis. In Spain they constitute approximately 30% of all RIs and generate

some 80% of waste which is managed by Enresa.

- Installations related to industry and agriculture: these produce small quantities of waste on an occasional basis. They constitute 60% of all installations in Spain and generate approximately 5% of all managed waste.

- Research and teaching centres: their production of waste is small but is on a regular basis. They represent 10% of all RIs and generate approximately 15% of managed waste.

The greater majority of waste generated in these installations can be included in the LILW group for inventory purposes. Nevertheless, since the waste delivered to Enresa is not conditioned, the treatment the waste must undergo when it arrives at El Cabril facility is the classification criterion adopted. The following codes are used in this classification:

- S-01: Compactable solid waste
- S-02: Non compactable solid waste
- S-03: Animal carcasses and biological waste
- S-04: Hypodermic needles in rigid containers
- S-05: Other special solids not covered by the above codes
- M-01: Mixed waste composed of organic liquids plus vials
- M-05: Special mixed waste
- L-01: Organic liquid waste
- L-02: Aqueous liquid waste
- L-05: Special liquids
- F-01: Encapsulated sources with a radioactivity limit below that established for transport containers type A of the ADR Dangerous Goods Transport Regulation and with a volume less than 20 litres for the source and container combined.
- F-02: Encapsulated sources with the same radioactive life as F-01 but with a volume above 20 litres and below 80 litres.
- F-03: Encapsulated sources which exceed the limits of radioactivity or volumes established for the codes F-01 and F-02.

Figure 2 shows the proportion of each of these types of waste according to the current volume of waste generated annually at radioactive installations.

Depending on the type of installation in question, specific characteristics of the waste generated can be established, for example, in the case of medical installations this would comprise source, vials, hypodermic needles, aqueous liquids, biological residue and miscellaneous solids. As concerns industrial and agricultural installations this tends to be encapsulated sources, and in research and teaching institutions compactable and non compactable solids, aqueous and organic liquids, mixed waste and finally animal carcasses predominate.

3.5. Research reactors

In addition to the JEN-1 reactor at CIEMAT, whose dismantling is being considered within the PIMIC project, there are two other reactors in Spain called ARGOS and ARBI, located in Barcelona and Bilbao respectively. These reactors are currently dismantled and are both of the ARGONAUT type with a maximum power of 10 kW.

The Argos reactor began operations in 1963 and was finally shut down in 1977. In 1992 the process for removing the fuel began, its decommissioning was concluded in 2002 and the declaration of closure was approved in 2003. Its dismantling generated no radioactive waste.

The Arbi reactor began operations in 1962 and was closed down in 1972. The fuel was removed in 1992 and decommissioning was completed in 2004. The declaration of closure was granted in 2005. In this case, LILW and other waste from fuel reprocessing in the United Kingdom were generated.

3.6. Mining and production of uranium concentrates

All the installations in Spain which were previously involved in the mining and production of uranium concentrates are currently dismantled or are awaiting dismantling and rehabilitation. An overview of these installations is given in Table 2.

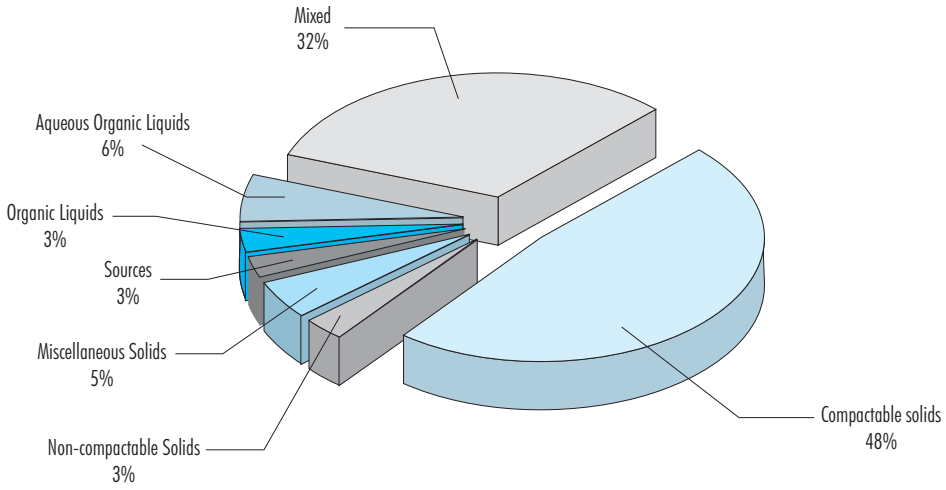


Figure 2: Types of radioactive waste in RIs.

The waste generated in the mining and production of uranium concentrates is not technically considered radioactive waste since it contains a naturally occurring low level of radioactivity. Nevertheless, this waste constitutes a large volume and requires specific management activities which Enresa is involved in.

The waste generated by these installations derives from the operations which the mineral is subjected to. The first process is the extraction of the mineral from the mine when the waste generated consists of all sterile materials where the concentration of uranium is below the level considered to be feasible. This primary waste is termed mining tailings. The second operation is the extraction of the uranium oxide from the mineral which exceeds the concentration level described above. This operation consists of leaching by using an acid or base medium depending on the type of mineral. This second operation generates the spent mineral tailings of the leaching pools.

The final operation entails the extraction of the uranium from the leaching liquid and this is done by liquid-liquid extraction and subsequent precipitation as ammonium diuranate. The liquid sub-products are neutralised and belong to the third group of waste called neutralisation sludge.

In this waste the representative isotope is Ra-226, which is found in concentrations of approximately 3 Bq/g in mining tailings, 9 Bq/g in the leaching pools and 12 Bq/ g in neutralisation sludge.

3.7. El Cabril Disposal Facility

The LILW disposal facility at Sierra Albarrana (El Cabril) began operations in1961 when it began to store the waste from the Beta Mine: other storage facilities were later added and in 1985 the facility was operating with three storage modules with a capacity of 15,000 drums of 220 l. The extension of the facility to its present capacity began in 1992 when the first operating licence was granted.

The El Cabril disposal facility has conditioning systems (incineration and immobilisation) for waste from radioactive installations as well as for the secondary waste which is generated at the facility. It also employs a super-compaction process for compactable waste from nuclear installations and from radioactive installations.

With regard to disposal, El Cabril has 28 cells with an individual capacity for 320 type CE-2a or CJE-1 rack storage containers, that is to say, it has a total capacity for 8,960 containers of these two types.

Table 2.
Mining and uranium concentrate production installations

Installation	Location (Province)	Current situation	Comments
Uranium facility of Andujar (FUA)	Jaén	Phase of monitoring and maintenance	Dismantling and rehabilitation work was completed in 1994
Lobo-G plant (La Haba)	Badajoz	Long term monitoring phase	Dismantling and rehabilitation work was completed in 1998
Elefante plant (Saelices el Chico)	Salamanca	Awaiting termination of dismantling work on other installations	Dismantling and rehabilitation work was completed in 2004
Quercus plant (Saelices el Chico)	Salamanca	Final shutdown	Dismantling planned to start in 2008
Mining excavations (Saelices el Chico)	Salamanca	Rehabilitation phase	Rehabilitation begun in 2004
Old mines	Cáceres, Badajoz, Jaén and Córdoba	Refurbished	Dismantling and rehabilitation work was completed in 2000
Old mines	Salamanca	Awaiting authorisation for rehabilitation	Rehabilitation planned to start in 2006

Both containers have a paralepipedic shape and outer dimensions measuring 2.25 x 2.25 x 2.20 metres, a total volume of 11.14 m^3. Once the LILW pieces are inside, the type CE-2a weighs around 24 metric tons and the type CJE-1 weighs 12 metric tons. Each CE-2a container normally contains 18 units of 220 l drums, 4 CMT containers of 1,320 litres or 30 pellets, as a mean value, in the case of super-compaction of compactable waste.

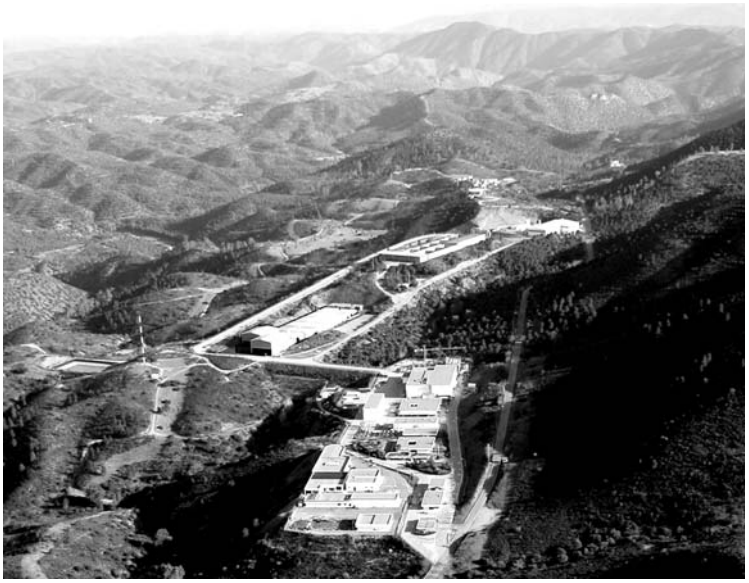
The CJE-1 racks contain 12 packages of unit volumes of 400 and 480 litres. In the case of CE-2a containers, in addition to the waste packages or pellets, a hydraulic conglomerate is incorporated into the container to immobilise and seal it. Immobilisation normally contains aqueous liquid waste generated in radioactive installations.

According to the above data, the disposal capacity of the 28 cells in El Cabril can be estimated at approximately 100,000 m^3 if the exterior volume of each one of the 8,960 containers in these cells is considered or some 44,000 m^3 if the original volume of the waste packages is taken into account before being placed in the containers.

The LILW streams which arrive at El Cabril and the treatment they are subjected to must be differentiated.

Firstly, the main stream is made up of the waste received from the nuclear power plants, the bulk of which is generated during operation of these plants since, as of 31 December 2004, only waste from the dismantling process to level 2 from Vandellos I had been received. All this waste is conditioned by the nuclear power plants before transport, and complies with the official acceptance criteria for LILW packages. At El Cabril, the packages are classified into the following groups in accordance with the activities to be carried out regarding their disposal:

- Compactable waste packages which are subjected to a super-compaction process which reduces their volume in order to fit into a CE-2a container holding approximately 30 pellets.



Aerial view of the El Cabril LILW.

Immobilisation and sealing mortar is added and a type CE-2a disposal unit is created

- Non-compactable packages which in turn are classified as per their volume and are basically divided into 220 litre drums, 1,320 litre CMT metal containers and 480 litre storage units. The first two are placed in CE-2a containers, immobilisation and sealing mortar are added, and the latter is placed in CJE-1 racks.

Secondly, waste from radioactive installations is also delivered and arrives at El Cabril in a non-conditioned state except for the waste which arrives as compactable packages. At the facility they are subjected to an incineration process (organic liquids, biological waste and certain compactable solids), placed in a 220 litre drum for immobilisation (non compactable solids, encapsulated sources, hypodermic needles and ashes from the incineration process) and lastly, the sealing mortar is mixed and poured into the CE-2a containers (aqueous liquids). The 220 litre units are generated during treatment, as are the units of compactable waste, and subsequently undergo the same conditioning process described above for waste from nuclear power plants.

Thirdly there is the waste generated during radiological incidents in steel yards. The first delivery took place in 1998 due to the smelting of a radioactive source of Cs-137. Up to 31 December 2004, there had been four incidents which resulted in a significant volume of this waste being delivered to El Cabril.

This waste is being stored temporarily, awaiting a treatment process in order to reduce the volume based on the substitution of the sand by this waste which is added to the sealing mortar and is then incorporated into the type CE-2a disposal units.

Fourthly, there is the waste from CIEMAT, which, since it has both radioactive and nuclear installations, sends either conditioned or unconditioned waste, depending on the installation the waste was generated at.

Finally, the *fifth type* of waste (compactable and non-compactable solids) generated during the dismantling operations of the 22,000 radioactive lightning rods which have been taken out of service in Spain. The majority of this secondary waste was received between the years 1992 and 1995.

CE-2a container with 220 l.

In addition to the waste received at El Cabril, the waste produced in the El Cabril facility itself should be taken into account as well as the waste stored temporarily in the old installations of the Beta Mine and the auxiliary buildings, which were later transported to the modules where they were stored at the start-up date of the current installation.

Figure 3 shows the annual volume of waste received at El Cabril, dividing it into three basic groups: Nuclear Installations (operation and dismantling), Radioactive Installations (also including CIEMAT and secondary waste from lightning rods) and incidents in steel yards.

3.8. Waste in foreign installations

In order to complete the national inventory of radioactive waste, it is necessary to include the waste in foreign installations which was generated during waste treatment in Spain and transported to these installations and which will be returned to Spain within the next few years in accordance with contractual obligations due to the availability of installations in Spain which allow for its final management.

These foreign installations with Spanish waste are:

- COGEMA (France). This will retake waste generated as a result of fuel generated in the nuclear power plant of Vandellós 1 and reprocessed in the COGEMA installations (Marcoule and The Hague).
- Belgoprocess (Belgium). Waste generated from treating medium level liquids with alpha emitters sent by CIEMAT.
- UKAEA (United Kingdom). Waste generated from reprocessing fuel from the experimental ARBI reactor

A disposal vault with concrete containers CE-2a.

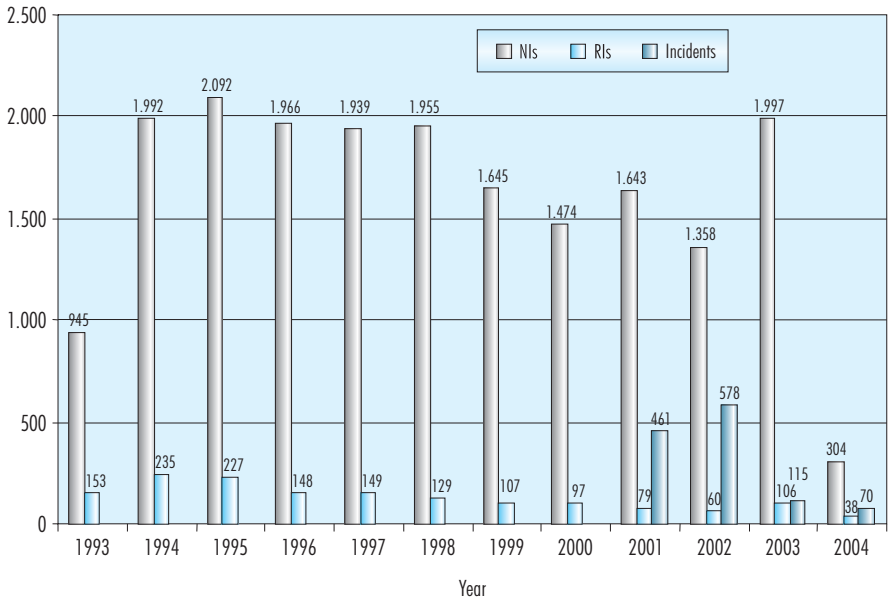


Figure 3: Annual volume of waste delivered to the El Cabril (m^3).

View of the installations at The Hague (COGEMA).

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4. Inventory by producer

4. Inventory by producer

4.1. Nuclear power plants

As a summary of section 3.1 and on an inventory level, the generation of radioactive waste during the operation of the nuclear power plants can be divided into the following four groups:

- Spent fuel
- Special waste
- LILW packages
- Dismantling waste

a) Inventory of spent fuel

As of 31 December 2004, the inventory of spent fuel in the nuclear power plants in Spain is provided in Table 3. All the fuel elements are stored in pools except for 168 elements from the Trillo nuclear power plant which are in 8 containers in the individual temporary storage facility of the plant.

According to the forecasts on waste generation corresponding to the hypotheses adopted in the reference scenario, the total to be managed in Spain is 19,283 fuel elements, as shown in Table 4. That is to say, as of 31 December 2004, the generation of spent fuel represents 48% of the total to be managed.

b) Inventory of special waste

The special waste stored as of 31 December 2004 in the nuclear power plants is shown in Table 5. This waste comprises components associated to fuel elements which have been subjected to neutron irradiation within the reactor nucleus:

The total inventory of this waste, which will have to be managed in principle as the spent fuel itself or as HLW, is estimated as double the figure shown in the table. This estimation is an adjustment of the inventory as of 31/12/2004 in relation to the spent fuel on that date and the overall fuel to be managed corresponding to the useful life of the power plants.

c) LILW

In 1968 LILW waste generation began in the José Cabrera nuclear power plant . The second production plant was Garoña in 1971. The nuclear power plants of Almaraz, Ascó and Cofrentes began their production of LILW in 1981, 1983 and 1984 respectively, and the last plants to generate operational waste were Vandellós II in 1988 and Trillo in

Table 3.
Inventory of spent fuel as of 31/12/2004

Nuclear Power plant	Elements	Metric Tons Uranium
José Cabrera	292	78
Garoña (BWR)	1,636	291
Almaraz I	944	436
Almaraz II	936	432
Ascó I	904	417
Ascó II	820	378
Cofrentes (BWR)	2,736	509
Vandellós II	712	329
Trillo	696	326
TOTAL	**9.676**	**3.195**

Table 4.
Total inventory of spent fuel

	Type PWR	Type BWR	Total
Fuel elements	11.383	7.900	19.283
Metric tons of uranium (tU)	5.190	1.450	6.641

Table 5.1.
Inventory of special waste as of 31/12/2004

PWR reactors	José Cabrera	Almaraz I y II	Ascó I y II	Vandellós II	Trillo
Control rods	20	100	99	57	—-
Neutron sources	14	12	10	4	4
Plugging devices	53	223	96	34	—-
Burnable poisons	—-	932	632	382	68
Instrumentation tubes	—-	10	14	—-	—-
Ducts	—-	—-	—-	—-	—-
Other	4	10	190	82	29

Table 5.2.
Inventory of special waste as of 31/12/2004

BWR reactors	Garoña	Cofrentes
Control rods	108	103
Neutron sources	5	5
Plugging devices		
Burnable poisons	172	
Instrumentation tubes	93	1
Ducts	1,648	2,426
Other	5	263

1989. Although the nuclear power plant of Vandellós I was in operation at a much earlier date, it was not until 1991 that it generated its first LILW package, until then the waste had been stored without conditioning.

During 2004 the nuclear power plants in operation generated 2,729 drums of 220 litres of conditioned LILW (600 m^3), with an estimated activity of 4.7 E+7 MBq, and a total of 1,368 were sent by Enresa to the El Cabril disposal facility. Figure 4 shows this data by installation.

Annual production of LILW from all the nuclear power plants has currently stabilised at between 550 m^3 and 650 m^3 (from 2,500 to 3,000 waste packages per year). These figures are due to the efforts made to secure a notable reduction in the generation of LILW and this was achieved by implementing a series of processes in the light water reactors with the support of Enresa in order to reduce volume. These processes are based on the introduction of equipment and systems for the treatment and conditioning of waste, all of which are aimed at minimising both the generation of waste and the reduction of the volume during conditioning. Figure 5 shows the variation in the annual generation figures at the nuclear power plants.

This figure is based on the year 1990, when approximately 1,500 m^3 (6,800 units of LILW) were generated and the 7 current light water reactors generated LILW waste units. Although there was a slight reduction over the next two years, the most significant reduction took place from 1993 to 1997 when the first processes to reduce volume were implemented. These are simple in nature and served as a pilot experience. Finally, the most important reduction corresponds to the period between the years 1998 and 2004, when the most widely reaching changes were introduced across all the nuclear power plants. If this average volume of waste generation for all three periods is classified while observing the type of conditioned waste (Figure 6), it can be observed that this decline was due primarily to the efforts to reduce the volume of compactable solid waste and concentrates from the evaporator.

The generation of LILW in each nuclear power plant as from the start of operations until 31 December 2004 was 26,000 m^3 and the existence of LILW waste in the storage facilities, after removing a total of 80,689 waste units to El Cabril (18,500 m^3),

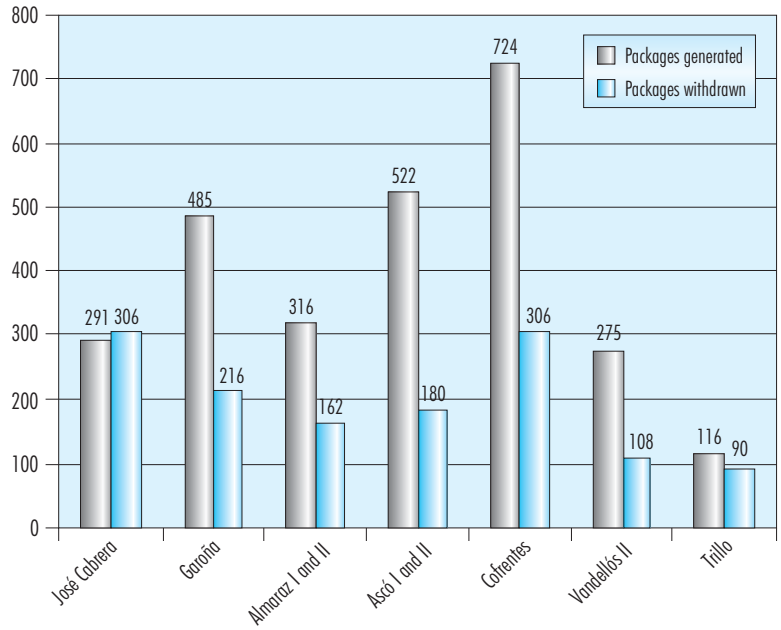

Figure 4: LILW packages generated and withdrawn during 2004 by nuclear power plant.

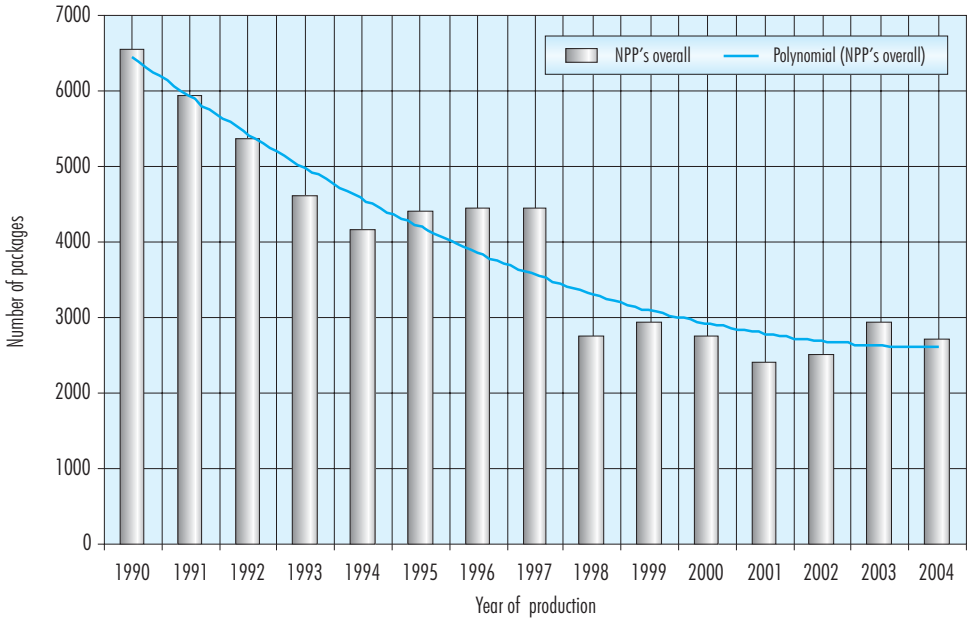

Figure 5: Annual generation of LILW packages at nuclear power plants.

which gives a percentage of approximately 71% of volume, are shown in Table 6.

The 106,015 waste packages generated up to 31 December 2004 (26,000 m^3) can be classified on the basis of the type of conditioned waste (Figure 7), the majority of which is compactable.

According to the inventory of activity, 5,880 m^3 is held in the storage facilities of the light water facilities and comprise around 1.6 E+9 MBq and Co-60 and Cs-137 are the isotopes which contribute primarily to radioactivity. With regard to the 1,580 m^3 in the graphite moderated gas plant of Vandellós I, the inventory of activity is 1.1 E+9 MBq, in this case the Co-60, Ni-93 and H-3 isotopes predominate.

The total inventory of LILW generated by the operations of nuclear power plants from start-up to the end of their useful lives (2,028 for the last nuclear power plants, Vandellós II and Trillo) is 36,300 m^3, of which some 18,500 m^3 had been removed as of 31 December 2004 and this represents 51% of the total volume to manage. Figure 8 shows the distribution of the total inventory per nuclear power plant and the total of LILW awaiting removal to El Cabril.

d) Decommisioning waste

In Spain, at 31 December 2004 in Spain the Vandellós I nuclear power plant had been dismantled to Level 2, and this stage was finalised in 2003. Currently the plant is in the latency stage which will last until the year 2030 when its radiological inventory will have substantially decayed and dismantling to level 3 will take place.

The LILW inventory corresponding to dismantling the Vandellós I INPP to level 2 is as follows:

	Packages	m^3
Generated waste	5,735	3,357
Waste removed as of 31-12-04	4,650	1,961
Waste in the nuclear power plant as of 31-12-04	1,085	1,396

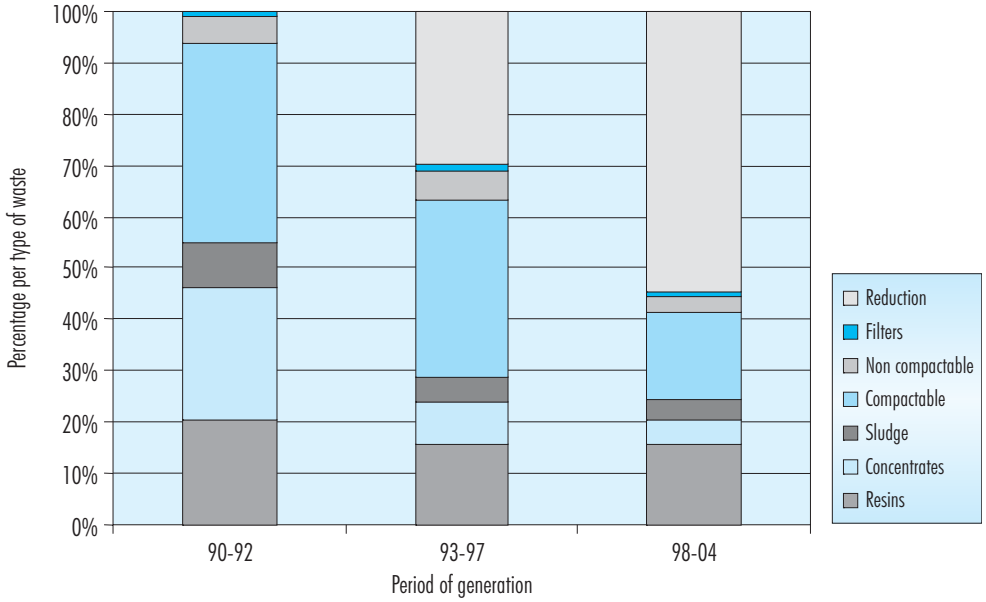

Figure 6: LILW Volume reduction at nuclear power plants.

Table 6.
LILW packages generated and stored at nuclear power plants as of 31/12/2004

Nuclear Power Plant	LILW generated until 31/12/04		LILW stored until 31/12/2004	
	Waste units	Volume (m^3)	Waste units	Volume (m^3)
José Cabrera	14,730	4,130	2,165	711
Garoña	17,709	3,944	4,285	947
Almaraz I y II	20,254	4,604	6,479	1,574
Ascó I y II	16,808	3,823	2,728	631
Cofrentes	24,601	5,412	7,127	1,568
Vandellós II	4,478	957	1388	305
Trillo	5,136	1,083	651	144
Vandellós I	2,299	2,000	503	1,580
Total	**106,015**	**25,953**	**25,326**	**7,460**

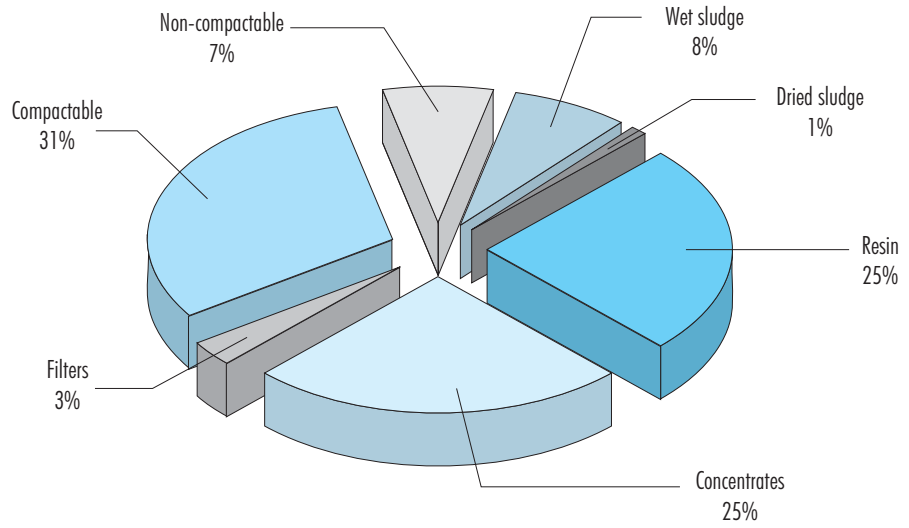

Figure 7: LILW inventory as of 31/12/2004 by type of conditioned waste.

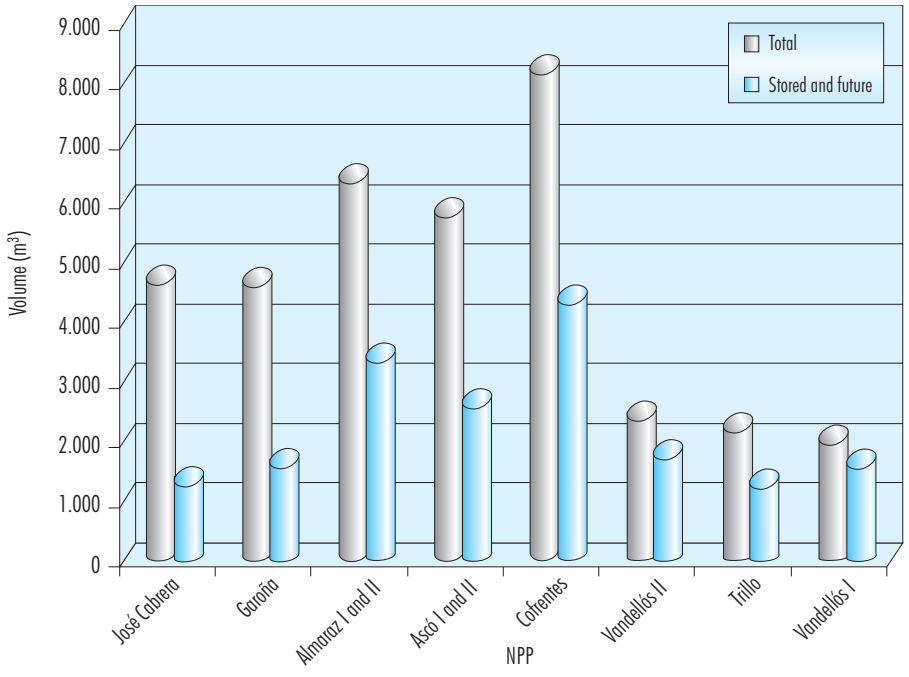

Figure 8: Total inventory of operation LILW and pending LILW (stored and future).

The 1,400 m^3 of LILW stored in the nuclear power plant as of 31 December have a radioactivity of 1.6 E+05 MBq, and the predominant isotopes are Co-60, Cs-137 and Pu-241.

From 2009 onwards, when the dismantling of the José Cabrera is planned and up to the year 2037 when the dismantling process of the last power plant of the present nuclear power plants is planned, the estimated volume of LILW will be 126,700 m^3, as shown with the breakdown for each nuclear power plant in Figure 9.

Figure 10 shows a comparison of the overall inventory of LILW (166,400 m^3) to be generated during the dismantling operations of the nuclear power plants.

Furthermore, during the decommissioning of nuclear power plants, it is estimated that a volume of waste will be generated which cannot be considered suitable for disposal at the El Cabril facility since it exceeds the radioactivity limits for LILW and therefore must be managed as intermediate to high level waste (MHLW). The estimated volume of this type of waste is in the order of 800 m^3 (Table 7).

4.2. Fuel element facility of Juzbado

As of 31 December 2004 the accumulated waste up to this date was 2,128 LILW packages which means a volume of 470 m^3. This volume of waste is provisional since a plan to reduce the volume of waste is in operation at the installation. This plan stipulates a series of waste management processes with the aim of achieving the least possible volume of radioactive waste; estimates indicate this could be reduced by some 150 m^3.

Since a volume in the order of 1 m^3 has been removed from El Cabril alone, and corresponds to contaminated oils for incineration, in practice, it is considered that the above figures for waste generation correspond to the volume in existence at the

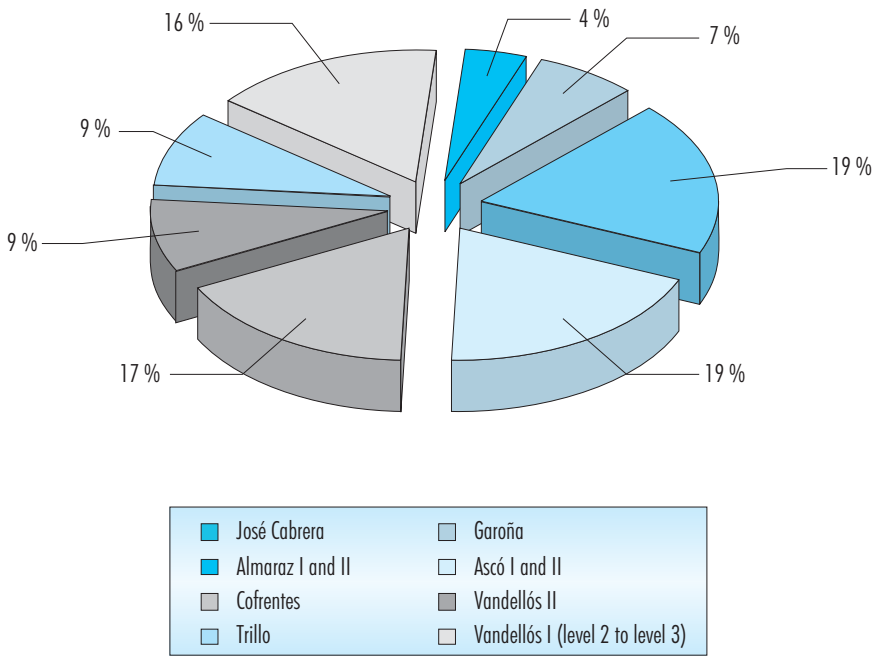

Figure 9: LILW inventory generated during dismantling of nuclear power plants.

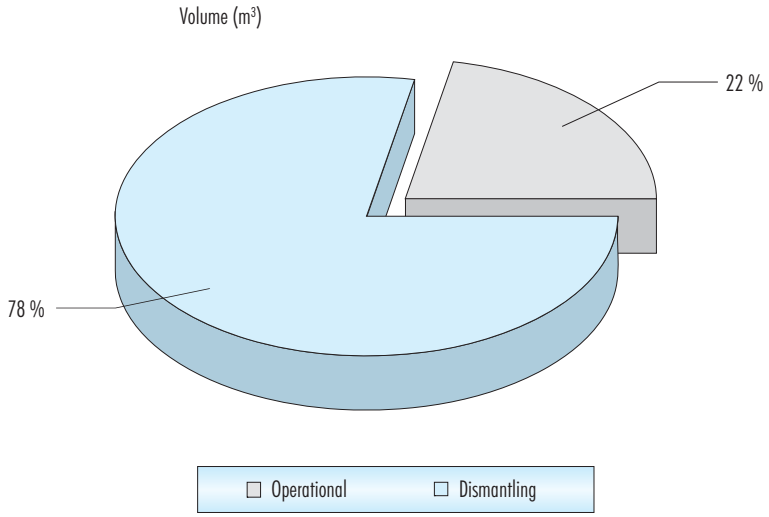

Figure 10: Comparison of the overall inventory of LILW in nuclear centres.

Table 7.
MHLW inventory to be generated during dismantling of nuclear power plants

Nuclear Power Plant	LILW Volume (m^3)
José Cabrera	50
Garoña	10
Almaraz I y II	220
Ascó I and II	220
Cofrentes	20
Vandellós II	110
Trillo	110
Vandellós I	50
Total	**800**

Juzbado facility and assumes radioactivity of 1.3 E+05 MBq, with predominant isotopes U-234, U-235 and U-238 in corresponding proportion to an average degree of uranium enrichment of 3.5%.

The generation of LILW envisaged is approximately 10 m^3 per annum. On the basis of the reference scenario with the installation operative until the last reloading of fuel in the last Spanish nuclear power plant in operation, which would be the year 2027,

the total volume generated in the Juzbado plant would reach a figure of approximately 590 m^3.

In addition to the generation of operational waste, it is estimated that, during dismantling of installations which are subject to radiological regulation, a volume of LILW will be generated in the order of 50 m^3. That is, the total inventory of LILW from this installation will be 640 m^3 (Figure 11).

4.3. Research Centre for Energy, Environmental and Technology (CIEMAT)

On 31 December 2004 the volume of waste in the storage facilities of CIEMAT amounted to approximately 20 m^3, and the vast majority was waste derived from the handling of waste delivered by Enresa. The predominant isotopes are Ra-226 and Am-241.

The generation of waste can be estimated currently at 16 m^3 per annum, a figure which corresponds to the waste removed by Enresa, which amounted to approximately 80 m^3 during the period between 2000 and 2004 inclusive.

The start of the PIMIC project is planned for 2006 in the dismantling area, and the rehabilitation project is already underway. The duration of the project is estimated at three years and the generation of LILW is calculated as follows:

- *Dismantling project:* some 330 m^3 of conditioned waste containing mainly debris, metal scrap and compactable materials are forecast. Furthermore, it is estimated that approximately 300 m^3 of soil will be generated although this figure is subject to revision in line with the execution radiological characterisation activities once the project has begun.
- *Rehabilitation project:* approximately 400 m^3 of conditioned waste containing basically debris and soil is are estimated.

Once the rehabilitation and dismantling stages of the PIMIC project are concluded, it is estimated that the generation of waste arising from the operations of the CIEMAT installations which remain operative will stand at approximately 5 m^3/year on average.

4.4. Radioactive Installations (RIs)

Since the generation of waste at the radioactive installations and the removal of the same by Enresa are concatenated activities, it is estimated that the existence of waste in these installations will be practically zero for inventory purposes. In practice it is

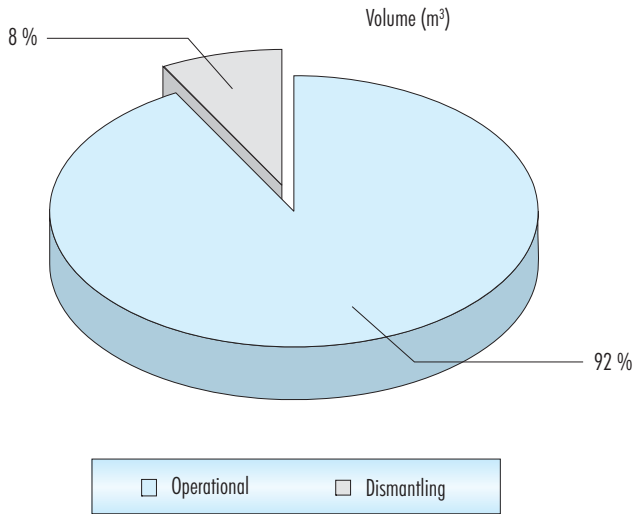

Figure 11: Comparison of the total inventory of LILW at Juzbado.

very possible that the waste which is to be removed during the initial months of 2005 will be found in these installations as of 31 December 2004.

The estimation of waste generation for these installations is based on the amounts removed over the past years and uses the annual average of waste removed as a forecast of the annual generation.

During the period from 1 January 2000 to 31 December 2004, the waste removed comprised a volume of approximately 257 m^3 derived from 415 installations. Table 8 gives an overview of RIs and the waste removed from each one, as well as the average annual volume during the period mentioned above.

In addition to the volume removed from these RIs, during the period 2000-2004, Enresa removed some 20 m^3 of waste not ascribed to any radioactive installations, that is to say, waste from installations outside nuclear regulatory control.

The removal of waste from RIs and its generation is currently decreasing due to the legislation issued during 2003 which sets out limits to radioactive activity in the case of solid materials regarding whether this waste is radioactive or not. In 2005 the figure for generation and removal was around 25 m^3, and this trend is expected to continue in the future. Figure 12 shows the annual volume of waste received by Enresa at the El Cabril disposal facility, taking into account all the radioactive installations and CIEMAT.

4.5. Research reactors

The Argos reactor did not generate any radioactive waste, while the Arbi reactor produced 11 m^3 of LILW as a result of its dismantling, as well as the waste derived from fuel reprocessing carried out at the Dounreay facility in the United Kingdom.

LILW has been delivered to the El Cabril facility and has been inventoried as deriving from RIs. Since the fuel has hardly been used, the volume of waste is relatively small (between 1 and 2 m^3). This waste is currently in the United Kingdom and is dealt with in section 4.8 of this document.

4.6. Mining and production plants for uranium concentrates

The waste inventory as of 31 December 2004 corresponds to the final inventory of this waste since the

Hypodermic syringe container at a nuclear medical unit.

Table 8.
Overview of RIs per Autonomous Community generating radioactive waste during the period 2000-2004

Autonomou Community	Province	Number of installations	Volume removed (m^3)	% over total volume removed	Average annual volume (m^3/year)
Madrid	Madrid	85	93.8	36.5	18.8
Catalonia	Barcelona	97	69.9	27.2	14.0
	Tarragona	8	0.9	0.4	0.2
	Lérida	3	0.2	0.1	< 0.1
	Gerona	3	< 0.1	< 0.1	< 0.1
Basque Country	Vizcaya	19	21.1	8.2	4.2
	Guipúzcoa	9	1.2	0.5	0.2
	Álava	8	0.9	0.4	0.2
Galicia	La Coruña	16	13.1	5.1	2.6
	Pontevedra	9	1.0	0.4	0.2
	Lugo	1	0.1	< 0.1	< 0.1
	Orense	2	< 0.1	< 0.1	< 0.1
Community of Valencia	Valencia	20	9.7	3.8	1.9
	Alicante	2	0.5	0.2	0.1
	Castellón	4	< 0.1	< 0.1	< 0.1
Navarre	Navarre	7	7.1	2.7	1.4
Andalusia	Seville	15	5.5	2.1	1.1
	Granada	17	5.4	2.1	1.1
	Málaga	3	1.0	0.4	0.2
	Cádiz	6	0.7	0.3	0.1
	Huelva	2	0.2	0.1	< 0.1
	Córdoba	1	0.1	< 0.1	< 0.1
	Jaén	1	< 0.1	< 0.1	< 0.1
	Almería	1	< 0.1	< 0.1	< 0.1
Cantabria	Santander	5	4.7	1.8	0.9

Table 8 (cont.)
Overview of RIs per Autonomous Community generating radioactive waste during the period 2000-2004

Autonomou Community	Province	Number of installations	Volume removed (m^3)	% over total volume removed	Average annual volume (m^3/year)
Region of Murcia	Murcia	9	4.4	1.7	0.9
Balearic Islands	Balearic Islands	4	3.3	1.3	0.7
Castile and Leon	Salamanca	5	3.0	1.2	0.6
	León	2	1.8	0.7	0.4
	Valladolid	6	0.5	0.2	0.1
	Burgos	2	< 0.1	< 0.1	< 0.1
Castile and Leon	Segovia	2	< 0.1	< 0.1	< 0.1
	Soria	1	< 0.1	< 0.1	< 0.1
	Ávila				
	Zamora				
Canary Islands	Gran Canaria	6	2.2	0.8	0.4
	Tenerife	11	1.8	0.7	0.4
Princedom of Asturias	Asturias	3	0.8	0.3	0.2
Castile-La Mancha	Ciudad Real	2	0.8	0.3	0.2
	Toledo	1	0.5	0.2	0.1
	Albacete	1	< 0.1	< 0.1	< 0.1
	Cuenca	1	< 0.1	< 0.1	< 0.1
	Guadalajara				
Aragon	Zaragoza	12	0.6	0.2	0.1
	Teruel	1	< 0.1	< 0.1	< 0.1
	Huesca				
Extremadura	Badajoz	1	0.4	0.2	0.1
	Cáceres				
La Rioja	Logroño	1	0.1	< 0.1	< 0.1
TOTAL		**415**	**257**	**100**	**51.5**

producer activities of all the installations are considered to have concluded. The amounts of waste at each of these installations, expressed in millions of metric tons, is given in Table 9.

4.7. El Cabril Disposal Facility

As of 31 December 2004 the LILW inventory in El Cabril corresponds to a volume of 27,230 m^3, this volume corresponds to the waste delivered to the installation but does not take into account the reduction in volume which the processes prior to waste disposal will have effected through incineration and super-compaction. Of these 27,230 m^3, a total of 22,570 m^3 are located in the disposal vaults.

In addition, as of 31 December 2004, in the various temporary storage units of El Cabril, a volume of 4,660 m^3 was registered, distributed among the modules (1,940 m^3), the transit building for deliveries (610 m^3), ISOs in storage cells (1,920 m^3) and other provisional storage facilities (190 m^3).

Table 10 gives an inventory of the LILW waste at the El Cabril facility, as of 31 December 2004, classified by producing plant and illustrated in Figure 13.

The 22,570 m^3 of waste in cells correspond to 94,127 units which, regardless of whether they are units or super-compaction pellets, have been placed in 4,466 type CE-2a and 128 CJE-1 rack disposal units . These units occupy 14.36 cells, which means there is a percentage of occupation of 51.3% compared to the total capacity of the 28 cells available.

Figure 14 shows the total amount of containers of type CE-2a and CJE-1 racks in the disposal cells during the years of operation at El Cabril. Figure 15 shows the procedure for filling the disposal cells at El Cabril.

4.8. Waste at foreign installations

The inventory of the waste as of 31 December 2004 is shown in Table 11, and HLW accounts for 85 containers of vitrified fission products.

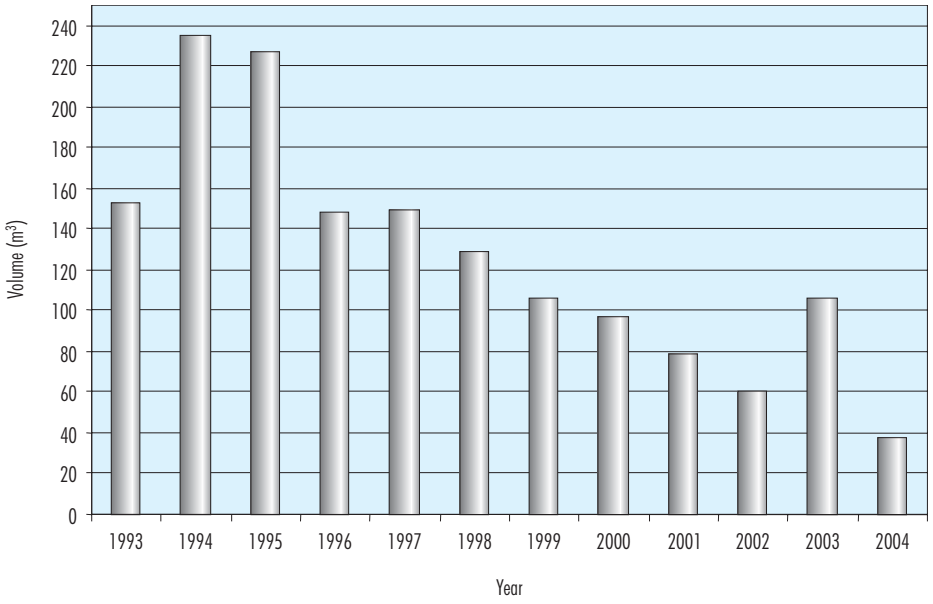

Figure 12: Annual volume of waste delivered to the El Cabril disposal facility.

Table 9.
Inventory of waste from mining installations and factories for uranium concentrates

Installation	Mining tailings	Leaching zones	Neutralisation sludge
Uranium facility of Andujar (FUA)			1.2
Plant Lobo-G (La Haba)	6.3		0.3
Plant Elefante (Saelices el Chico)		7.2	0.3
Plant Quercus (Saelices el Chico)	2.7	1.2	0.8
Mining activity (Saelices el Chico)	68.0		
Old mines	0.3		
Total (Mt)	**77.3**	**8.4**	**2.6**

Table 10.
LILW inventory at El Cabril as of 31/12/04

Producing plant	Volume stored in cells (m^3)	Volume in temporary storage (m^3)	Total volume at El Cabril (m^3)
Operation of nuclear power plants	17,900	600	18,500
Dismantling of Vandellós I	1,720	220	1,940
Radioactive installations	1,370	150	1,520
Incidents in steelworks	70	2.430	2,500
CIEMAT	260	40	300
Secondary waste from dismounting of lightning rods	210	90	300
El Cabril installation	490	40	530
Waste from old installations	550	1.090	1,640
TOTAL	**22,570**	**4,660**	**27,230**

Table 11.
Inventory of waste at foreign installations as of 31/12/04

	LILW (m^3)	MHLW (m^3)	HLW (m^3)
COGEMA (France)	400	215	13
BELGOPROCESS (Belgium)			0.15
UKAEA (United Kingdom)	0.44	1.27	
TOTAL	**400.44**	**216.27**	**13.15**

Location of the Uranium Concentrates Facility at Andujar after dismantling.

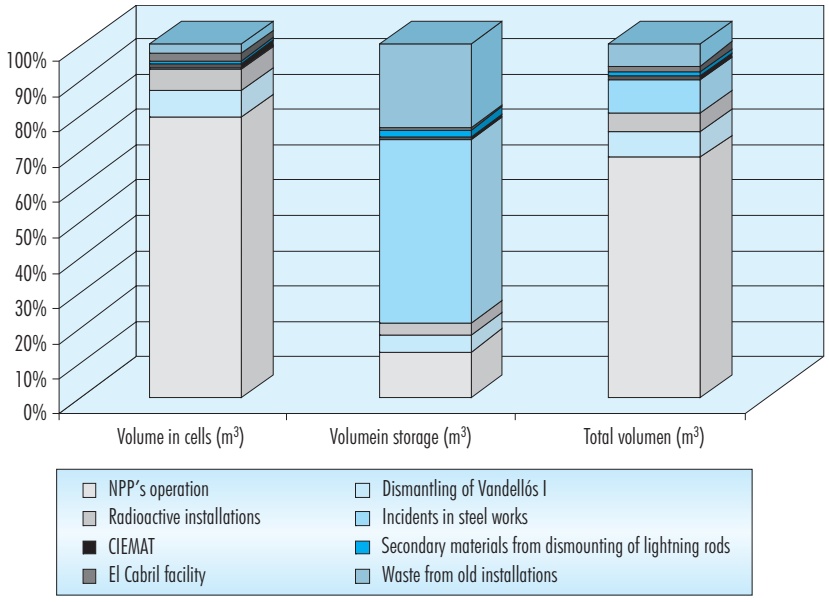

Figure 13: LILW inventory in El Cabril as of 31/12/04.

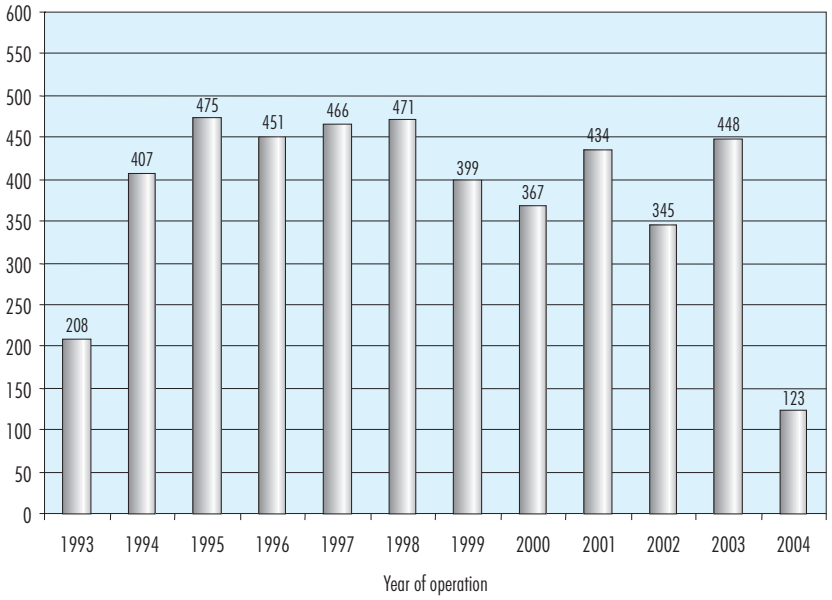

Figure 14: Containers and racks disposed of in cells.

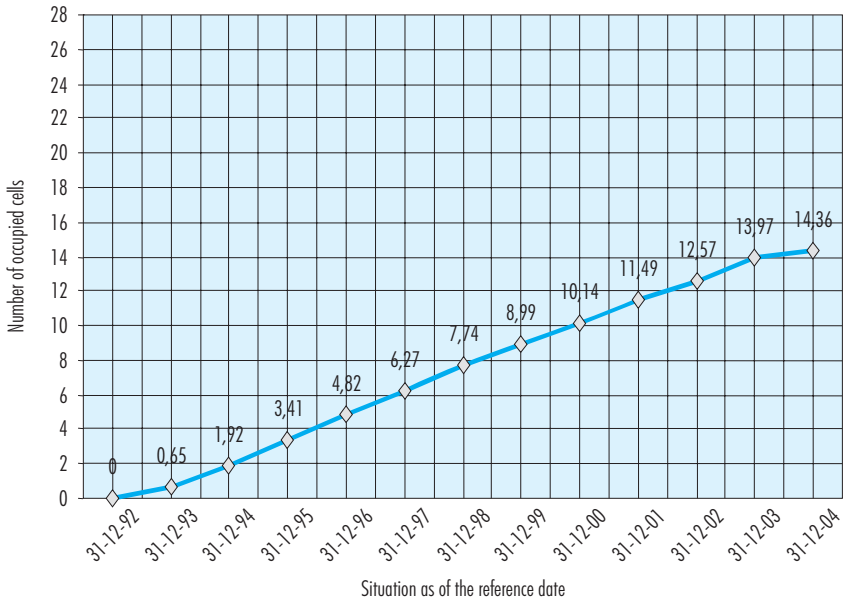

Figure 15: Trend of occupation of storage cells in El Cabril.

5. Summary of the Inventory

5. Summary of the Inventory

In accordance with the data stated, this section will provide a summary of the inventory by type of waste: fuel, high activity, medium-high activity and low-medium activity. This last group is differentiated in order to take into account the waste described as very low level (VLLW) since a new method of managing this waste is underway with the introduction at El Cabril of a specific type of disposal in specially designed additional cells.

The summary is divided into the following two subsections:

- Inventory as of 31 December 2004.
- Total inventory to be managed.

In addition, it should be taken into account that waste from mining and the plants for uranium concentrates listed in section 4.6, Table 9 as waste to be managed, although, as this will undergo specific treatment, it will not be included in this summary.

5.1. Inventory as of 31 December 2004

This inventory based on the type of waste is shown in Table 12. Of the total volume of LILW it should be stated that, in view of the new subdivision created within this type of waste for very low level waste (VLLW), out of 14,410 m^3 which had not been stored definitively in cells as of 31 December 2004, some 5,800 m^3 (40%) will be managed as VLLW and the rest comprising approximately 8,600 m^3 will be managed using current methods, by placing them in type CE-2a or in CJE-1 rack disposal units.

This total volume of LILW itemised according to location and derivation (Figures 16, 17 and 18) shows that 76% (7,460 m^3) of the inventory in the storage units of producers is at nuclear power plants and 68% (18,500 m^3) in El Cabril comes from these power plants.

It should also be pointed out that, prior to 31 December 2004, a series of waste from foreign installations arrived at the El Cabril facility, and this had been generated from the treatment of Spanish waste. This waste was inventoried on arrival at the facility and included in the inventory of the Spanish installation where the primary waste is generated. This case was applied to the waste from the SIEMPELKAMP (Germany) facility for fuel racks from Ascó, which were inventoried as operational waste from nuclear power plants and also the waste from treatment of liquid waste from CIEMAT at Belgoprocess (Belgium), which was inventoried as waste from this producer.

5.2. Total inventory to be managed

The total inventory according to the different types of waste to be managed is shown in the following table (Table 13).

The total inventory of LILW has forecast a volume of approximately 178,700 m^3, which is broken down by origin (Figure 19) and shows that 93% proceeds from nuclear power plants (166,340 m^3), and 76%

Table 12.
Inventory as of 31/12/04

Type of waste	Volume (m^3)	Comments
Spent fuel	3,195 tU	5,304 PWR elements and 4,372 BWR elements
HLW	13	85 containers of vitrified fission products
MLW/HLW	216	
LILW	36,980	9,750 at the producer's storage facility and 27,230 at El Cabril (22,570 in cells)

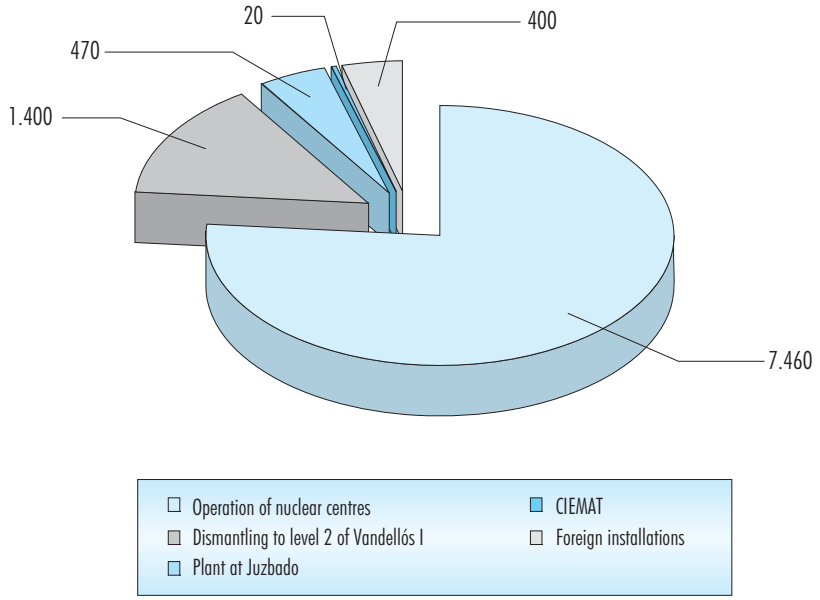

Figure 16 : LILW inventory for producers as of 31/12/04.

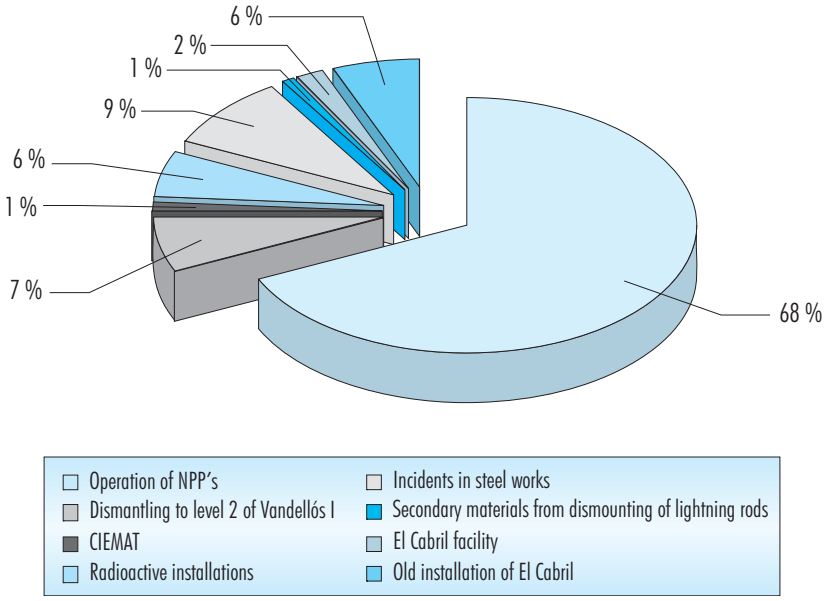

Figure 17: LILW inventory at El Cabril according to their origin as of 31/12/04.

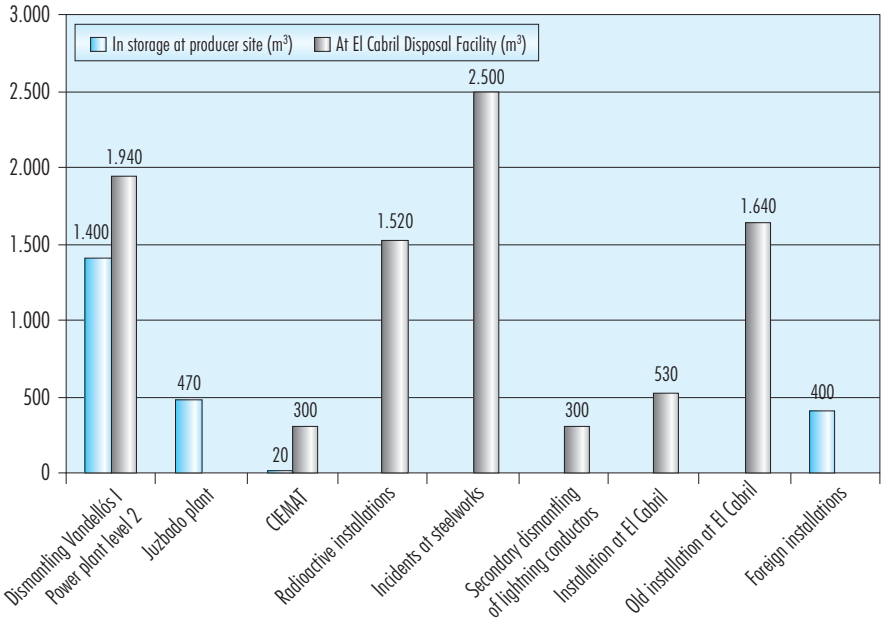

Figure 18: Inventory as of 31/12/04 (excluding the waste from the operations of nuclear .

of this (126,700 m^3) is derived from dismantling to level 3 the nuclear reactors in Spain.

These percentages are derived from the data shown in the following table (Table 14).

Discounting the 110,000 m^3 of VLLW, the remaining 68,700 m^3 are planned to be stored long term in cells using the type CE-2a and CJE-1 rack disposal units. Due to the fact that, as of 31 December 2004, 14.36 cells of the current 28 are occupied and contain 22,570 m^3, a volume in the order of some 21.500 m^3 can be stored in the 13.64 cells remaining. New storage cells (maximum 16) are planned for the approximately 24,600 m^3 which remain to complete the overall inventory of LILW.

Table 13.
Total inventory of radioactive waste

Type of waste	Volume (m^3)	Comments
Spent fuel	6,641 tU	11,383 PWR elements and 7,900 BWR elements
HLW	13	85 containers of vitrified fission products
MLW/HLW	1.016	Of which 800 were generated during dismantling of nuclear power plants
LILW	178,700	110,000 corresponding to VLLW

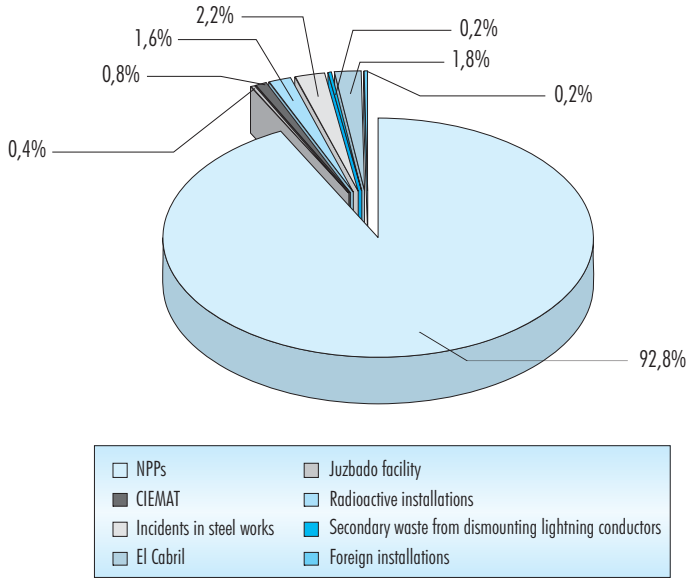

Figure 19: Total inventory of LILW in Spain.

Table 14.
Total inventory of LILW

Origin	Volume (m^3)
Nuclear power plant operations	36,300
Level 2 dismantling of Vandellós I	3,400
Level 3 dismantling of nuclear power plants	126,700
Operation and dismantling of the Juzbado plant	600
CIEMAT operations (*)	500
Dismantling and rehabilitation of CIEMAT	1,000
Radioactive installations (*)	2,400
Incidents in steel works	4,000
Secondary waste from dismounting lightning rods	300
El Cabril facility	1,500
Old installation at El Cabril	1,600
Foreign installations	400
TOTAL	**178,700**

(*): The estimation for the generation of waste from RIs and CIEMAT has been calculated up to and including the year 2038. From this date only the LILW from these producer centres will be managed, that is to say approximate 30 m^3 per year.

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12 CARACTERIZACIÓN Y LIXIVIACIÓN DE COMBUSTIBLES NUCLEARES IRRADIADOS Y DE SUS ANÁLOGOS QUÍMICOS.

2001

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2002

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2006

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